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(71) Applicant: THE WHITAKER CORPORATION
4550 New Linden Hill Road,
Suite 450
Wilmington, Delaware 19808 (US)

(72) Inventor: Bair, William Herbert
101 Scenic Drive
Marysville, Pennsylvania 18053 (US)
Inventor: Folk, Kenneth Foster
320 Fresno Drive
Harrisburg, Pennsylvania 17112 (US)
Inventor: Skotek, David Anthony
5522 Edsel Street
Harrisburg, Pennsylvania 17109 (US)

(74) Representative: Warren, Keith Stanley et al
BARON & WARREN
18 South End
Kensington
London W8 5BU (GB)

(54) RAM drive mechanism.

(57) A ram drive mechanism for an automated terminal crimping machine of the type having a rotating crank shaft with an offset crank pin (2) protruding therefrom and orbiting about the rotation axis of the crank shaft. The mechanism includes a ram (20) mounted for reciprocating motion in a first direction toward a crimping zone and in a second direction away from a crimping zone. The ram (20) carries tooling for performing a terminal crimping operation. The mechanism also includes a ram drive linkage comprising a drive link (40) having a pivotal connection with the crank pin (2) at one end. Another end of the drive link (40) has a pivotal connection with a link pin (50). The drive linkage reciprocates the ram (20) in accordance with orbiting of the crank pin (2). The ram (20) is arranged such that the one end of the drive link (40) is disposed relatively further in the first direction than the other end of the drive link (40), whereby the drive link (40) is in tension during the reciprocation of the ram (20) toward the crimping zone.

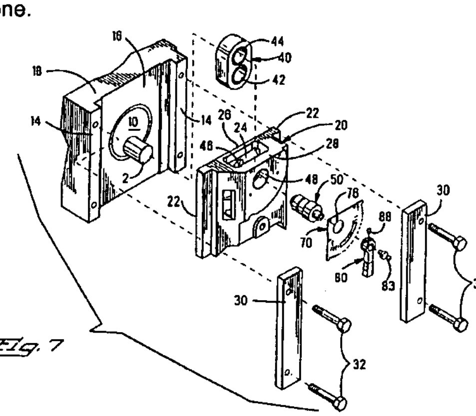

Fig. 7

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The present invention relates to a machine for crimping electrical terminals to conductors and, in particular, to a ram drive linkage for an automated terminal crimping machine and an adjustable pin for the ram drive linkage thereby allowing selection of the proper crimp height.

Automatic crimping presses have long been used in the connector industry to effect high-speed mass termination of various cables. Figs. 1 and 2 are side and front views, respectively, of one exemplary automatic crimping "T-terminating unit" Model No. 768793 which is commercially available from AMP, Incorporated. In general, such presses include a reciprocating ram group 1 which is driven by an electric motor 3 through a torque multiplication mechanism 5. Various crimping tool-heads may be secured to the underside of ram group 1, and the attached tool head is driven with the ram group into proximity with a continuous-feed applicator 8, which tenders the terminals to be crimped.

Significant torque multiplication is necessary to generate a sufficient downward force for the crimping operation, and this is accomplished in the illustrated machine by a pulley-driven torque multiplication mechanism 5. More specifically, the electric motor 3 is housed on a lower shelf of the illustrated press. The motor 3 drives a pulley 4 which is housed in the rear of the press. The pulley 4 drives a belt 7 which extends upwardly and encircles a large flywheel 9, which in turn drives a cylindrical crank shaft through a clutch enclosed in flywheel 9. The crank shaft is rotatably seated in the upper section of the press and runs to the front of the press. An offset crank pin 2 protrudes forwardly from an end face of the crank shaft. The crank pin 2 is offset from the rotation axis of the crank shaft and orbits about the axis as the crank shaft is rotated.

The conventional automatic crimping presses are of a push link design wherein the crank pin 2 is directly coupled to a push link 6, which is in turn coupled to a ram 20 through a ball joint and socket 11. The crank pin 2 compresses the push link 6 and ram 20 downwardly during 180° of its orbit to advance the entire ram group 1 and crimping tool head toward the applicator 8. This illustrated press and its commercial counterparts do not allow convenient adjustment of the crimp height to compensate for such things as tooling wear, dimensional tolerances of replacement parts, and dimensional changes due to temperature variations. Furthermore, the current configuration of the ram group 1 renders it difficult to incorporate a suitable retrofit adjustment feature.

Moreover, although the ram group 1 is reciprocated over a distance equal to a stroke length of the crank pin 2 which may be, for example, 1.625", the terminals are crimped in a crimping zone which extends only over a final portion of the downward displacement of the ram group, i.e., the final 0.1" of the downward displacement. Force required to displace the ram group 1 is relatively low except during actual crimping of the terminal, when forces on the order of several thousand pounds are required to deform the terminal. A greater mechanical advantage of the ram drive could be achieved by extending the portion of rotation of the crank pin 2 during which actual crimping occurs, thereby reducing a size requirement for the motor 3. Therefore, it would be desirable to concentrate most of the ram displacement during the early portion of the crank pin rotation away from top dead center so that a larger portion of the crank pin rotation could be devoted to performing the actual crimping. However, the existing push link design tends to produce a majority of the downward ram displacement during the final 90° of downward rotation of the crank pin, as shown by a plot of ram displacement versus crank pin rotation in Figure 6. The plot of ram displacement versus crank pin rotation can be altered by altering the length of the push link, but at best, the push link design can only be made to produce an equal displacement of the ram during the initial 90° of crank pin downward rotation and the final 90° of crank pin downward rotation, i.e., a pure sinusoidal motion. It would be advantageous to provide a crimping machine which produces a majority of the ram displacement during the initial 90° of crank pin downward rotation in order to increase the angle of crank pin rotation devoted to performing the crimping. The present invention accomplishes this by employing a tensioned linkage to pull the ram downward rather than compressive force on a push link. The present invention also facilitates the OEM or retrofit addition of a crimp height adjustment feature.

It is a feature of the invention to provide an improved ram drive mechanism for an automated terminal crimping machine.

It is another feature of the invention to provide a ram drive mechanism that increases force concentration at the bottom of a ram drive stroke.

It is yet another feature of the invention to provide a ram drive mechanism having a reduced power input requirement.

It is still another feature of the invention to provide a ram drive mechanism having lighter weight drive components and reduced overall structure size.

It is still another feature of the invention to provide a ram drive mechanism wherein all moving parts of the drive linkage are contained behind the ram and are shielded thereby for the safety of the operator.

It is still another feature of the invention to provide a ram drive mechanism which facilitates the addition of a crimp height adjustment feature.

These and other features are accomplished by a ram drive mechanism including a drive shaft having an offset drive member at one end which orbits about an axis of the drive shaft during rotation thereof. Means such as an electric motor are provided for rotating the crank shaft. A ram is mounted for reciprocating motion in a first direction toward a crimping zone and in a second direction away from the crimping zone. A drive link has one end pivotally connected to the drive member and an other end coupled to the ram for reciprocating the ram in accordance with the orbiting of the drive member. The ram is arranged such that the one end of the drive link is disposed relatively further in the first direction than the other end of the drive link. By this arrangement, the drive link is in tension during the reciprocation of the ram toward the crimping zone. This pull link arrangement increases the angle of crank shaft rotation that is available for moving the ram when the ram is in the crimping zone, thereby increasing force concentration on the ram in the crimping zone.

In accordance with another aspect of the invention, a portion of the ram defines a cavity bounded by walls, and the ram carries a link pin which extends through the cavity and is supported by opposite ones of the walls. An aperture extends from the cavity through one of the opposite walls. The drive member comprises a crank pin extending from the one end of the crank shaft through the aperture. The drive link is disposed within the cavity, and the one end of the drive link defines a bore which receives the crank pin therein.

A ram drive mechanism for an automated terminal crimping machine, comprising a crank shaft having an offset drive member at one end which orbits about an axis of the crank shaft during rotation thereof; means for rotating the crank shaft; a ram mounted for reciprocating motion in a first direction toward a crimping zone and in a second direction away from the crimping zone; and a drive link having one end pivotally connected to the drive member and an other end coupled to the ram for reciprocating the ram in accordance with the orbiting of the drive member the ram is arranged such that the one end of the drive link is disposed relatively further in the first direction than the other end of the drive link, whereby the drive link is in tension during the reciprocation of the ram toward the crimping zone.

The "T-terminating unit" Model No. 768793 of FIGS. 1 and 2 has an existing crimp height adjustment mechanism. Crimp height refers to the vertical height of a terminal after it has been crimped in the press. The crimp height is a function of the shut height of the press, i.e., a dimension between upper and lower crimping tooling when the ram 20 is at a lowermost extent of its stroke. The lower crimping tooling toward which the attached tool head is driven sits upon a precision adjustment base 12. The precision adjustment base 12 may be offset vertically by turning adjustment knob 13, and changing the offset of the base 12 and lower crimping tooling results in a change in crimp height. Unfortunately, the adjustment mechanism including adjustment base 12, knob 13, and all components in between are complex and precision machined parts. The complexity of the mechanism renders it strictly OEM, and it cannot be offered as a retrofit feature. More importantly, the complexity unduly elevates the cost of the "T-terminating unit". In addition, the mechanism lies beneath the work area and is susceptible to clogging by dirt and debris.

Notwithstanding the awkward crimp height adjustment feature, still further problems are engendered by the existing ram drive assembly. For instance, there is imperfect power transmission from the crank pin 2 through to the ram 20, and this results in a less than optimal force at the point of crimping, and possible structural damage to the press. These problems are confronted and solved by the improved ram drive mechanism as described herein which utilizes the improved crimp height adjustment mechanism, and such is another feature of the present invention. It would be greatly advantageous to provide a simplified design for the adjustment mechanism which reduces costs, raises it above the work area, and allows it to be retrofitted to an existing "T-terminating unit".

The present invention also provides an improved crimp height adjustment mechanism to be carried within a reciprocating ram of an automated terminal crimping machine as set forth herein for adjusting the crimp height thereof. The crimp height adjustment mechanism of the present invention includes a cylindrical crimp height adjustment pin carried by the reciprocating ram of the crimping machine. The crimp height adjustment pin has an eccentric intermediate section which is coupled in a bearing engagement with the drive linkage of the crimping machine. A rotator is attached to the crimp height adjustment pin for allowing controlled rotation of the eccentric intermediate section. By controlling rotation of the eccentric intermediate section of the crimp height adjustment pin (via the rotator), the ram may be vertically offset to thereby adjust the crimp height of the machine.

The rotator may be a simple manual adjustment arm attached to the crimp height adjustment pin exteriorly of the ram for allowing leveraged rotation of the adjustment pin. Alternatively, the rotator may be an automatic assembly such as a

first rotary gear attached to the crimp height adjustment pin exteriorly of the ram, a shaft having a worm gear at one end for engagement with the first rotary gear, and an electric motor mounted independently of the ram and engaged with the other end of the shaft for imparting rotation thereto to thereby rotate the eccentric section of the pivot pin. In either case, the invention provides for convenient "on-the-fly" adjustment of the crimp height of terminals crimped in the machine.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings in which:

FIGS. 1 and 2 are side and front perspective views, respectively, of a conventional automated terminal crimping machine.

FIG. 3 is an exploded perspective view of the ram drive mechanism according to the present invention.

FIG. 4 is a side cross-sectional view of the ram drive mechanism of FIG. 3.

FIG. 5 is a front cut-away view of the ram drive mechanism of FIGS. 3 and 4.

FIG. 6 is a graph of ram displacement vs. crank shaft rotation for a prior art crimping press having a push link and for a crimping press having a pull link ram drive mechanism according to the invention.

FIG. 7 is an exploded perspective view of a crimp height adjustment pin according to the present invention which is incorporated in a ram drive mechanism as set forth in Figs. 3-6.

FIG. 8 is a back view of the ram of FIG. 7.

FIG. 9 is a side cross-sectional view of the ram drive mechanism with crimp height adjustment pin of FIG. 7.

FIG. 10 is a front cut-away view of the ram drive mechanism with crimp height adjustment pin of FIG. 7.

FIG. 11 is a top view of the ram and crimp height adjustment pin of FIGS. 7-10.

FIG. 12 is a front view of the ram and crimp height adjustment pin of FIGS. 7-10.

FIG. 13 is an enlarged side view of the crimp height adjustment pin according to the invention.

FIG. 14 is an enlarged perspective view of the crimp height adjustment pin according to the invention.

FIG. 15 is a breakaway perspective view of an automated terminal crimping machine which incorporates an alternative motorized crimp height adjustment mechanism according to the present invention.

FIGS. 1 and 2 illustrate an existing automatic crimping "T-terminating unit" Model No. 768793 which is commercially available from AMP, Incorporated. Such a press can be modified by incorporating the ram drive mechanism of the present invention. The press includes a ram group 1 including a reciprocating ram 20 which is driven by an electric motor 3 through a torque multiplication mechanism 5. A crank shaft is rotatably seated in an upper section of the press for transferring motion from the torque multiplication mechanism 5 to the ram group 1. Various crimping tool-heads may be secured to the underside of the ram 20, and the attached tool head is driven downward by the ram 20 into working proximity with a continuous-feed terminal applicator 8 which positions terminals to be crimped.

FIG. 3 is an exploded perspective view of the ram drive mechanism of the present invention incorporated in the automatic terminal crimping machine shown in FIGS. 1 and 2. The crank shaft 10 in FIG. 3, extends to a front of the press, and drive member 2 protrudes forwardly from the end face of the crank shaft. In the embodiment shown, the drive member 2 is a crank pin which is offset from a rotation axis of the crank shaft and orbits about the axis as the crank shaft rotates. However, other equivalent configurations for the drive member 2, such as an offset bore defined in the end face of the crank shaft 10, will be readily apparent to those skilled in the art, and the drive member 10 is intended to include all equivalent configurations without limitation to this embodiment.

The ram drive mechanism of the present invention includes a modified ram 20 which is formed as a hollow block with flanged edges 22 on either side. An interior of the hollow block defines a cavity 24. The ram 20 is received within channel 16 defined between side rails 14 of the press. The ram 20 is held captive within the channel 16 by a pair of gibs 30 which are secured to the side rails 14 of the press by threaded fasteners 32. The edges 22 are slidably held behind the gibs 30 to permit vertical sliding movement of the ram 20.

A back wall 26 of the ram 20 defines an aperture 38, shown in FIG. 4, which provides an opening through which the crank pin 2 extends into the cavity 24. The aperture 38 is sufficiently large to provide clearance for unobstructed orbiting of the crank pin 2 therein.

As shown in FIGS. 3 and 4, a drive link 40 comprises an integral member having a lower bore 42 at one end and an upper bore 44 at an other end. The drive link 40 resides in the cavity 24 of the ram 20. The crank pin 2 protrudes through the aperture 38 (Fig. 8) and is pivotally received in the lower bore 42 of the drive link 40. From the pivotal connection with the crank pin 2, the drive link 40 extends upwardly within the cavity 24. The back wall 26 and front wall 28 of the ram 20 define through-bores 46, 48, respectively, at positions which correspond to the upper bore 44 of the drive link 40.

A link pin 50, described in detail hereafter, is pivotally received in the upper bore 44 of the drive link 40 and is secured within the bores 46, 48 of the ram 20. The link pin 50 provides a pivotal connection of the drive link 40 to the ram 20. Hence, the ram drive linkage of the present invention includes a first, or lower, pivotal connection between the crank pin 2 and the drive link 40 via the crank pin 2 nesting in the lower bore 42, and a second, or upper, pivotal connection between the ram 20 and drive link 40 via the link pin 50 nesting in the upper bore 44.

In operation, rotation of the crank shaft 10 effects an orbiting motion of the crank pin 2 about a rotation axis of the crank shaft 10. Each orbit of the crank pin 2 produces both a side-to-side displacement and a vertical displacement of the crank pin 2. The side-to-side component is absorbed by the drive link 40 which simply pivots back and forth in a pendulum motion. Hence, the side-to-side component generates no motion of the ram 20.

The vertical displacement component of the crank pin 2 is translated directly into a vertical reciprocating motion of the ram 20. As the crank pin 2 orbits upwardly, the drive link 40 is compressed against the link pin 50, which in turn slides the ram 20 upwardly between the rails 30. Conversely, downward displacement of the crank pin 2 tensions the drive link 40 and pulls the ram 20 downwardly between the side rails 14. It is this downward reciprocation of the ram 20 which results in a crimping blow against a terminal supported on lower crimping tooling on a base of the press.

The drive link 40 remains tensioned throughout the entire downward motion of the ram 20, and this tensioned drive favorably modifies the downward motion and force characteristics of the crimping blow. FIG. 6 graphically illustrates ram displacement as a function of crank shaft angle in a "T Terminator" press having the prior art push link design, and in a "G Terminator" press having a pull link ram drive mechanism according to the invention. As shown in FIG. 6, the "T Terminator" produces a ram displacement wherein a greater portion of the ram movement occurs in the final 90° of crank shaft rotation than in the initial 90° of crank shaft rotation. Also, the ram dwells in the "crimp zone", i.e., the final 0.1" of ram displacement, for approximately 28° of the crank shaft rotation. In comparison, the "G Terminator" produces approximately two-thirds of the ram downward displacement in the initial 90° of crank shaft rotation. Thereafter, the ram continues downward at a slower rate than the comparable ram on the "T Terminator". However, due to the large gain in displacement of the ram in the "G Terminator" during the initial 90° of crank shaft rotation, the ram enters the crimp zone approximately 43° before bottom dead center of the crank shaft rotation, thereby providing an increased dwell time in the crimp zone and increased force transmission through the ram for acting against the terminal.

In addition, moving parts of the ram drive linkage are contained behind the ram 20 and are shielded thereby for the safety of the operator.

Moreover, the use of the above-described ram drive linkage according to the present invention facilitates the use of a crimp height adjustment feature to compensate for tolerances in the tool heads, terminal pins, etc.

As shown in the break-away view of FIG. 5, the crimp height can be easily adjusted by varying the vertical separation d between the first pivotal connection with the crank pin 2, and the second pivotal connection with the link pin 50. The link pin 50 includes an eccentric, and the crimp height can be adjusted by rotatably adjusting the link pin 50 in the manner shown and described in conjunction with FIGS. 7-14.

As best seen in FIG. 10, the extent of the downward reciprocation is related to a distance D between an axis of the crimp height adjustment pin 50 and its point of bearing contact with the drive link 40 during the downward reciprocation. During the downward reciprocation of the ram 20, the drive link 40 is in tension and the point of bearing contact between the adjustment pin 50 and the drive link 40 is on the upper side of the adjustment pin 50 (as viewed in FIG. 10) along an imaginary line 36 which intersects central axis 59 of the adjustment pin 50 and central axis 15 of the crank pin 2 as the crank pin 2 rotates. When the ram 20 is at the uppermost and lowermost extremes of its downward stroke, the line 36 is vertical and the point of bearing contact is at a top point of the adjustment pin 50 (as viewed in FIG. 10). The crimp height adjustment pin 50 of the present invention allows convenient adjustment of the distance D in the following manner.

FIG. 13 is an enlarged side view of the crimp height adjustment pin 50 showing details of its design. The crimp height adjustment pin 50 defines a three-tier shaft having a first cylindrical section 51 of relatively small diameter, a second cylindrical section 52 of intermediate diameter, and a third cylindrical section 53 of larger diameter. The third section 53 is coaxial with the first section 51 on the pin axis 59. The intermediate section 52 has a central axis 55 which is parallel to and displaced from the pin axis 59. Thus, the intermediate section 52 is eccentric with respect to the pin axis 59. As shown in FIG. 13, the axis 55 of the intermediate section 52 is displaced from the pin axis 59 by an eccentric dimension E which is .010 inch.

Referring now to FIGS. 7 and 11, the crimp height adjustment pin 50 is disposed in the ram 20

such that the first section 51 is pivotally seated in the bore 46 in the back wall 26 of the ram 20, and the third section 53 is pivotally seated in the bore 48 in the front wall 28 of the ram 20. End face 66 of the intermediate section 52 bears against the back wall 26 and prevents travel of the pin 50 through the back wall of the ram. The intermediate section 52 resides in the upper bore 44 of the drive link 40 within the cavity 24 of the ram 20. Thus, the drive link 40 is held captive on the crimp height adjustment pin 50 between the front and back walls 28, 26 of the ram, the link 40 being in bearing contact with the intermediate section 52 of the pin 50.

Referring back to FIG. 10, a radial length of the intermediate section 52 defines the distance D. More specifically, the distance D is equal to a distance between the pin axis 59 (as defined by the coaxial first and third sections 51 and 53) and a point of bearing contact between the drive link 40 and the intermediate section 52. Since the intermediate section 52 is eccentric with respect to the pin axis 59, rotation of the pin 50 on its axis 59 produces a change in the distance D, thereby changing the shut height of the press and the crimp height of a terminal crimped therein. The intermediate section 52 may be selectively rotated by, for example, rotation of the entire pin 50 to thereby change the distance D between the axis 59 and the periphery of the intermediate section 52. Hence, the maximum downward extent of the ram 20 (and thus, the crimp height) may be altered by altering the angular orientation of the pin 50.

As shown in FIGS. 9 and 11, a grease fitting 83 is preferably provided to allow convenient lubrication. The grease fitting 83 is attached to the crimp height adjustment pin 50 which has a central passageway 68 therethrough to allow injection of grease. The grease flows along the passageway 68 and is expelled through a port 57 into a grease groove 56 around the periphery of the intermediate section 52, thereby providing lubrication for the upper pivotal connection of the drive link 40. Some of the grease is further communicated through a passageway 43 (FIG. 9) in the drive link 40 and is expelled at the lower bore 42, thereby providing lubrication for the lower pivotal connection of the drive link 40 with the crank pin 2, all from the front of the press.

A means for rotating the adjustment pin 50 is provided by rotator handle 80 which is attached to the adjustment pin 50 in front of the ram 20. One end of the rotator handle 80 has a throughbore 84 (FIGS. 9 and 11) which receives stem 54 of the adjustment pin 50. A setscrew 88 is engaged in cavity 74 (FIG. 13) in the stem 54 to lock the rotator handle 80 to the adjustment pin 50. The rotator handle 80 allows manual rotation of the adjustment pin 50 in order to selectively position the eccentric intermediate portion 52 at various orientations for performing crimp height adjustments. Consequently, a machine operator may reorient the crimp height adjustment pin 50 to thereby change the maximum downward displacement achievable by the ram 20 (i.e., the crimp height). The rotator handle 80 has a length which extends from the pin 50 to provide sufficient leverage for rotating the pin 50 so as to lift the ram 20 when an increased crimp height is desired.

The crimp height adjustment pin 50 is secured within ram 20 by a face plate 70 which is attached to the front wall 28 of the ram. The face plate 70 has an aperture 76 through which the stem 54 of the adjustment pin 50 protrudes. The aperture 76 has a smaller diameter than the third section 53, thus preventing withdrawal of the pin 50 through the front wall 28 when the face plate 70 is secured thereto.

The operation of the crimp height adjustment pin 50 will now be described. As shown in FIG. 9, the orbiting crank pin 2 of the crank shaft protrudes into ram 20 and is pivotally engaged within the lower bore 42 of the drive link 40. The upper bore 44 of the drive link 40 encircles the intermediate section 52 of the crimp height adjustment pin 50. All vertical displacement of the crank pin 2 is conveyed directly through the drive link 40 to generate the vertical reciprocations of the ram 20. As the crank pin 2 orbits downwardly, the crank pin 2 tensions the drive link 40 and pulls the ram 20 downwardly within the rails 30. This downward reciprocation of the ram 20 terminates in a crimping blow, and the extent of the downward reciprocation defines the crimp height. Once again, the downward extent is a function of the distance D between the axis of the crimp height adjustment pin 50 and its point of bearing contact with the drive link 40.

With reference to FIGS. 11 and 12, the rotator handle 80 extends perpendicularly with respect to the crimp height adjustment pin 50 and along a front face of the ram 20. A positive detent means for releasably holding the handle 80 in a selected angular orientation is provided by a detent pin 82 located at an end of the handle 80 which cooperates with a series of recesses 72 defined along an outer periphery of the face plate 70, the recesses 72 being arranged along the arcuate swing path of the detent pin 82. A spring 86 in the end of handle 80 biases the detent pin 82 radially inwardly to keep the detent pin 82 within one of the recesses 72. A finger grip portion 64 connected to the detent pin 82 is operable to move the detent pin radially outwardly to disengage the detent pin from the recesses so that the handle 80 can be selectively rotated to adjust the crimp height. The detent pin 82 and the recesses 72 cooperate to provide a

means for making precise incremental adjustments in crimp height and for retaining the selected crimp height until further adjustment is desired. Due to the configuration of the eccentric intermediate portion 52 of the pin 50, constant angular increments of rotation of the pin 50 result in varying incremental changes in crimp height. It is preferred that the detent means provide constant incremental changes in crimp height between each detent. Therefore, the recesses 72 are spaced at non-uniform distances along the arcuate swing path of the detent pin 82 such that moving the detent pin 82 between two adjacent ones of the recesses 72 effects a constant incremental change in crimp height which, in an embodiment preferred by applicants, is .0005 inch.

In various embodiments of the invention the handle 80 may be attached to the pin 50 such that the handle 80 extends in a direction which is angularly offset with respect to maximum eccentricity of the intermediate portion 52. It is preferred that the handle 80 be attached to the pin 50 such that when the handle 80 is disposed midway along its arcuate swing path as shown in FIG. 12, the press will produce a nominal crimp height midway between the maximim and minimum extremes of its adjustable range. As seen in FIG. 12, the apertures 72 are disposed over an approximately 130° range of the arcuate swing path of the handle 80. If desired, the arcuate swing path could be expanded to extend over a 180° range, thereby utilizing the entire range of crimp height adjustment available from the pin 50 having a fixed eccentric dimension E.

FIG. 15 illustrates an alternative embodiment for rotating the adjustment pin 50 in order to accomplish adjustment of the crimp height. Rather than manual rotator handle 80, a first rotary gear 90 is attached to crimp height adjustment pin 50 exteriorly of the ram 20. A pair of integral mounting brackets 92 are provided on the ram 20 adjacent the first rotary gear 90. The mounting brackets 92 hold first worm gear 93 on shaft 94 in engagement with the first rotary gear 90. The shaft 94 extends transversely with respect to the crimp height adjustment pin 50 and upward past the mounting brackets 92. A second rotary gear 96 is mounted on an upper end of the shaft 94. An actuating motor 98 seated within the terminal crimping press has a motor shaft connected to second worm gear 97 which engages the second rotary gear 96. The motor 98 may be any conventional motor including a stepping motor, which would allow incremental angular adjustment of the adjustment pin 50. Operation of the motor 98 turns the shaft 94, which in turn rotates the first rotary gear 90 as well as the crimp height adjustment pin 50. Using the embodiment of FIG. 15, adjustment of the crimp height may be accomplished automatically.

Claims

1. A ram drive mechanism for an automated terminal crimping machine, comprising:

   a crank shaft (10) having an offset drive member (2) at one end which orbits about an axis of the crank shaft (10) during rotation thereof;

   means (5) for rotating the crank shaft (10);

   a ram (20) mounted for reciprocating motion in a first direction toward a crimping zone and in a second direction away from the crimping zone; and,

   a drive link (40) having one end (42) pivotally connected to the drive member (2) and an other end (44) coupled to the ram (20) for reciprocating the ram (20) in accordance with the orbiting of the drive member;

   characterized in that the ram (20) is arranged such that the one end (42) of the drive link (40) is disposed relatively further in the first direction than the other end (44) of the drive link (40), whereby the drive link (40) is in tension during the reciprocation of the ram (20) toward the crimping zone.

2. The ram drive mechanism according to claim 1, characterized in that the other end (44) of the drive link (40) is pivotally connected to the ram (20).

3. The ram drive mechanism according to claim 1, characterized in that the ram (20) carries a link pin (50), and the other end (44) of the drive link (40) is pivotally connected to the link pin (50).

4. The ram drive mechanism according to claim 3, characterized in that a portion of the ram (20) defines a cavity (24) surrounded by walls (26, 28), the link pin (50) extends through the cavity (24) and is supported by opposite ones of the walls (26, 28), and the drive link (40) is disposed within the cavity (24).

5. The ram drive mechanism according to claim 4, characterized in that an aperture (38) extends from the cavity (24) through one of the opposite walls (26, 28) of the ram (20), the drive member (2) comprises a crank pin extending from the one end of the crank shaft (10) through the aperture (38), and the crank pin engages in a bore defined by the one end (42) of the drive link (40).

6. The ram drive mechanism according to claim 2, characterized in that said link pin (50) has an eccentric section (52) for providing a bearing engagement with the drive link (40), and a rotator (80; 90, 93, 96, 97, 98) connected to said link pin (50) for controlling rotation of said eccentric section (52), whereby the ram (20) can be vertically offset by controlled rotation of the eccentric section via said rotator thereby adjusting the crimp height of the crimping machine.

7. The ram drive mechanism of claim 6 characterized in that said rotator (80) comprises a manual adjustment arm attached to said pin (50) exteriorly of said ram (20) for allowing leveraged rotation of the link pin (50).

8. The ram drive mechanism of claim 7 characterized in that said manual adjustment arm (80) carries a detent pin (82) facing rearwardly for contact with the ram (20), and a plurality of apertures (72) are defined along said ram in an arcuate path for receiving said pin (82) in different ones of said apertures (72) according to a selected orientation of said adjustment arm (80).

9. The ram drive mechanism of claim 7 characterized in that said link pin (50) is provided with a grease fitting (83) facing outwardly from said adjustment arm (80) for injection of grease therein, and a central passage (68) in fluid communication with said grease fitting (83) for expelling injected grease outwardly at the eccentric section (52) to the drive link (40) of the crimping machine.

10. The crimp height adjustment mechanism of claim 6 characterized in that said rotator comprises a first rotary gear (90) fixed for rotation with the link pin (50), a shaft (94) connected to the ram carries a first worm gear (93) in engagement with the first rotary gear (90), and a motor (98) mounted independently of the ram is coupled to the shaft (94) for rotation thereof, said motor (98) incrementally rotating said first rotary gear (90) via said worm gear (93) to thereby rotate said link pin (50).

11. In an automated crimping machine including a crank shaft (10) rotatably driven by a motor, said crank shaft having an offset crank pin (2) protruding forwardly from one end for orbiting about an axis of said crank shaft during rotation thereof, a ram (20) slidably mounted with respect to said crank shaft (10) and driven thereby in a reciprocating motion, and a drive link (40) pivotally connecting said crank pin (2) to said ram (20) for reciprocating said ram (20) in accordance with the orbiting of said crank pin (2), characterized in that:

a crimp height adjustment pin (50) is carried by said ram (20) and coupled to said drive link (40) to allow adjustment of the reciprocation extent of said ram (20), said crimp height adjustment pin (50) having a pair of coaxial cylindrical sections (51, 53) pivotally carried by the reciprocating ram (20), and an eccentric cylindrical intermediate section (52) between the coaxial sections (51, 53) for providing a bearing engagement with the drive link (40) of the crimping machine; and

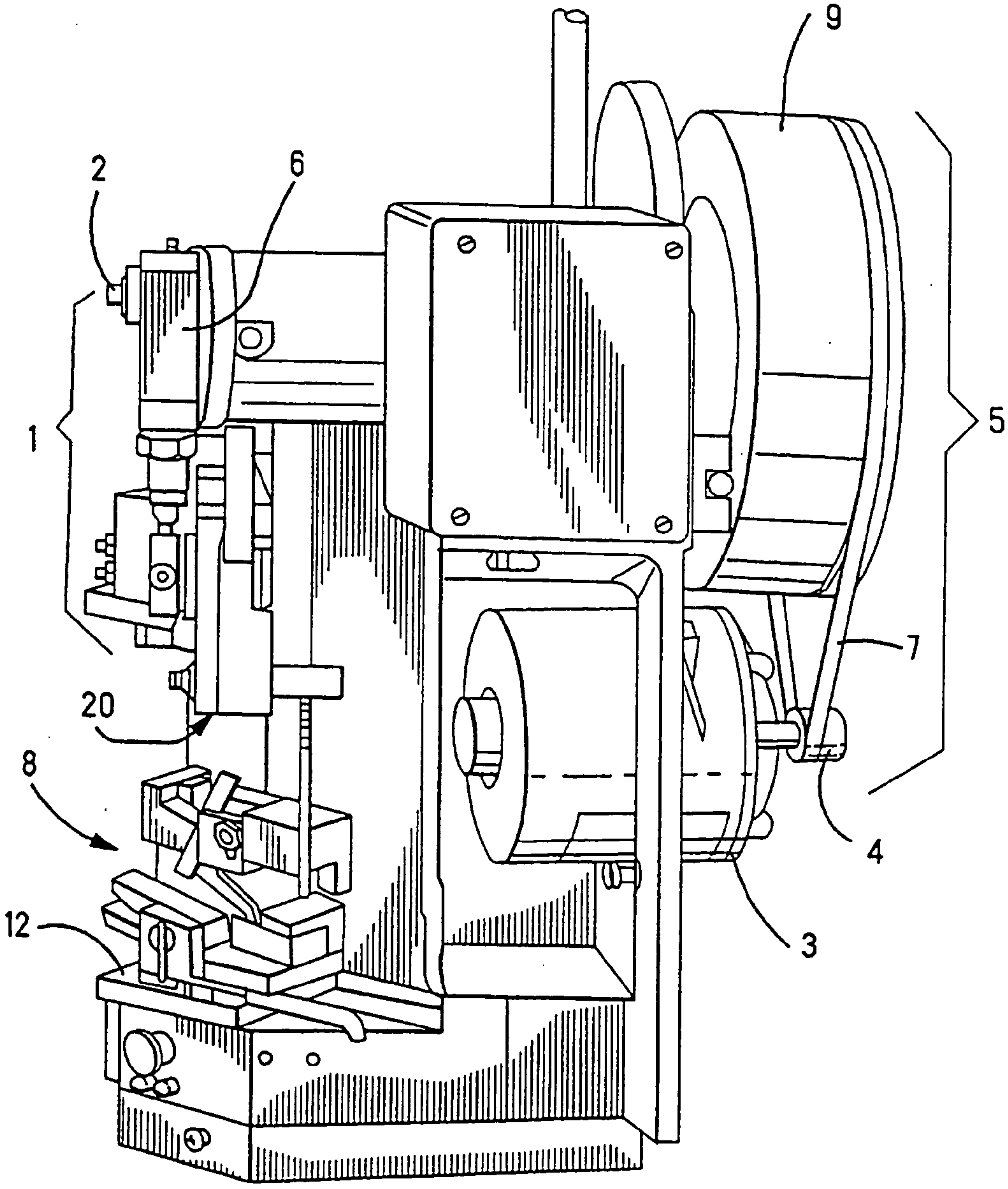
a rotator (80; 90, 93, 96, 97, 98) attached to said first end for allowing controlled rotation of said crimp height adjustment pin (50);

whereby a radial distance between the axis of said coaxial sections (51, 53) and the bearing engagement of said eccentric intermediate section (52) with said drive linkage (40) may be selectively varied by controlled rotation of said crimp height adjustment pin (50) to thereby adjust the reciprocation extent of said ram (20) and the corresponding crimp height of the crimping machine.

12. The crimp height adjustment mechanism of claim 11, characterized in that said rotator (80) further comprises an adjustment arm attached to said adjustment pin (50) exteriorly of said ram (20) for allowing leveraged rotation of said adjustment pin.

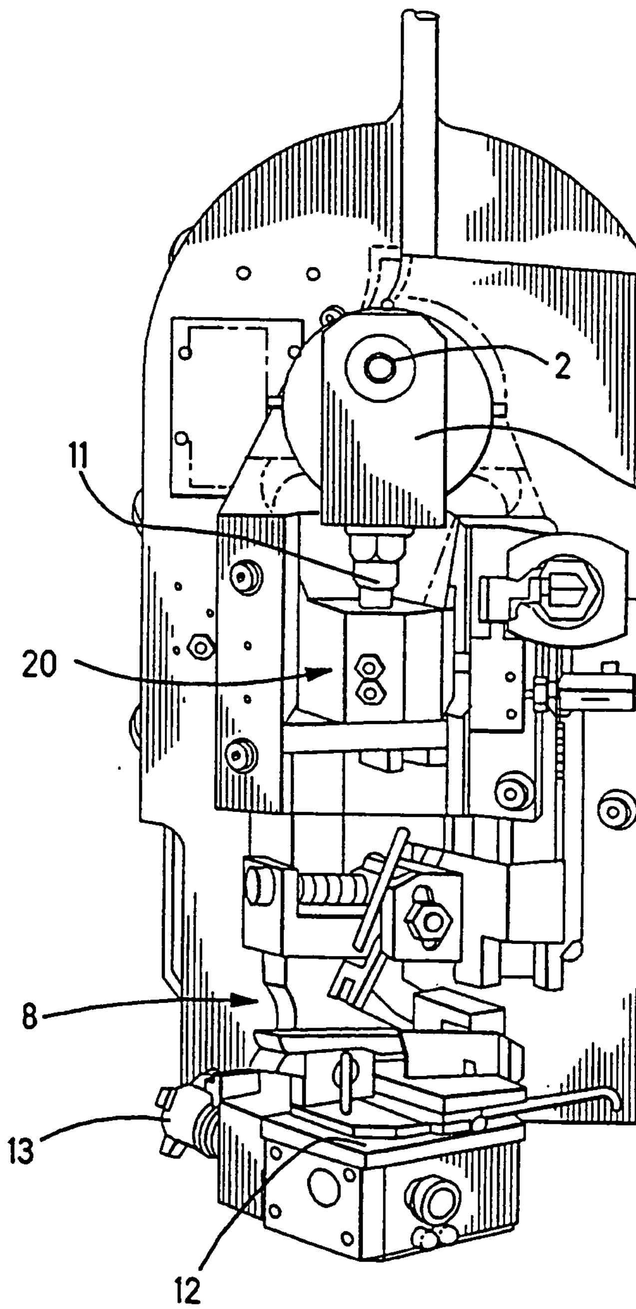
13. The crimp height adjustment mechanism of claim 12, characterized in that said adjustment arm (80) carries a detent pin (82) facing rearwardly for contact with the ram (20), and wherein a plurality of apertures (72) are defined along said ram (20) along an arcuate swing path for receiving said pin in different ones of said apertures according to a selected orientation of said adjustment arm.

14. The crimp height adjustment mechanism of claim 11, characterized in that said rotator comprises a first rotary gear (90) fixed for rotation with the adjustment pin (50), a shaft (94) connected to the ram carries a first worm gear (93) in engagement with the first rotary gear (90), and a motor (98) mounted independently of the ram is coupled to the shaft (94) for rotation thereof, said motor (98) incrementally rotating said first rotary gear (90) via said worm gear (93) to thereby rotate said adjustment pin (50).



PRIOR ART

Fig. 1



PRIOR ART

Fig. 2

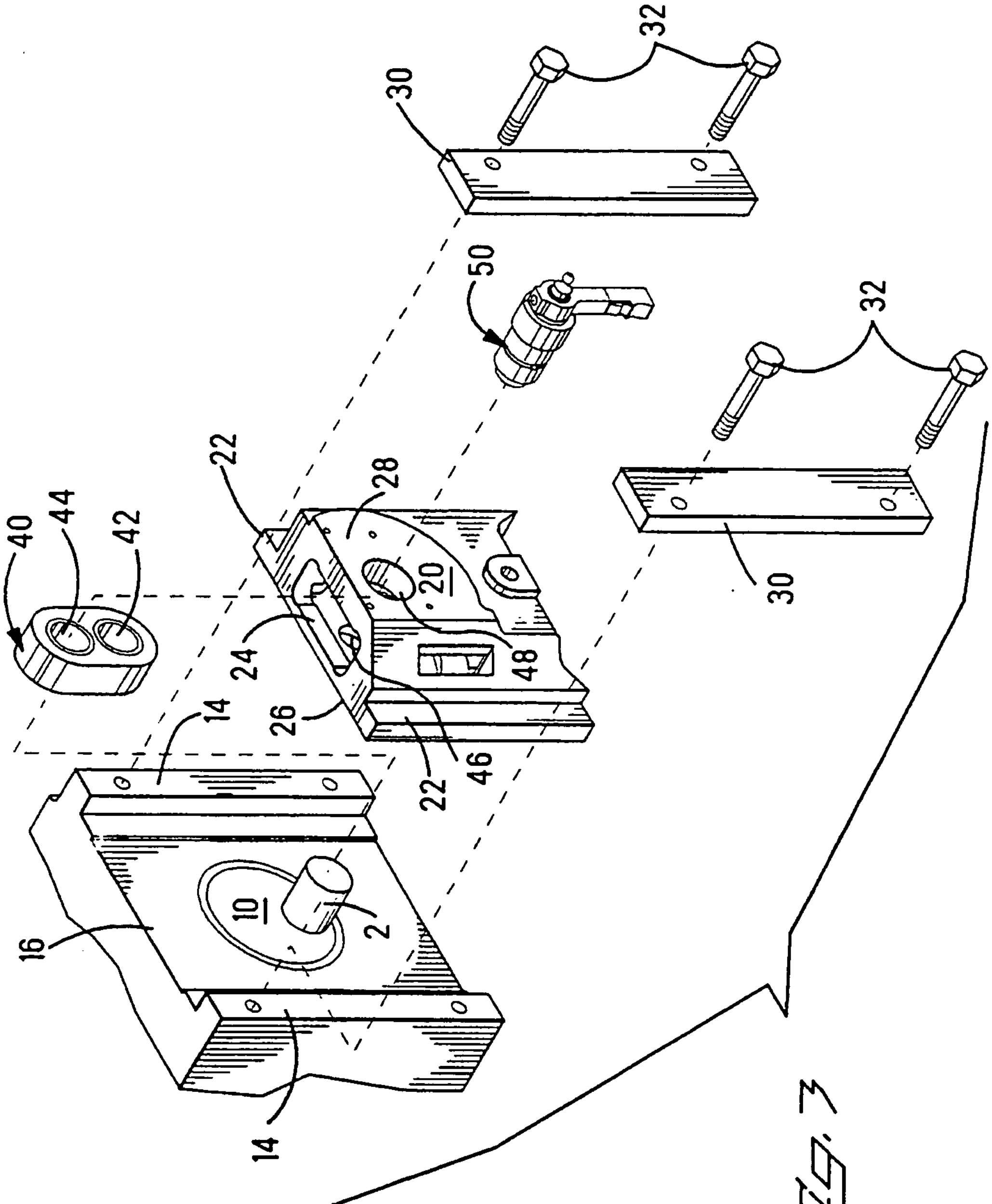
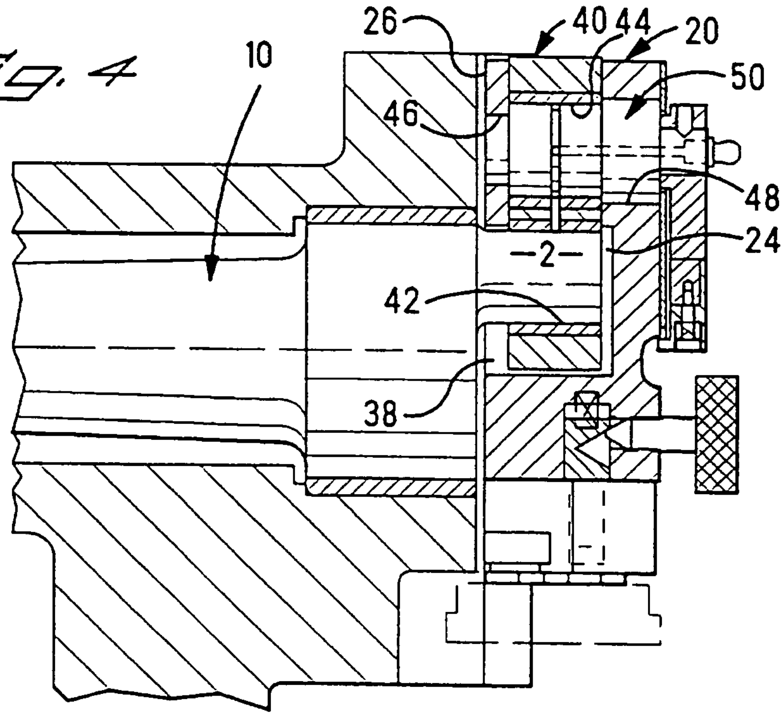


FIG. 3

Fig. 4



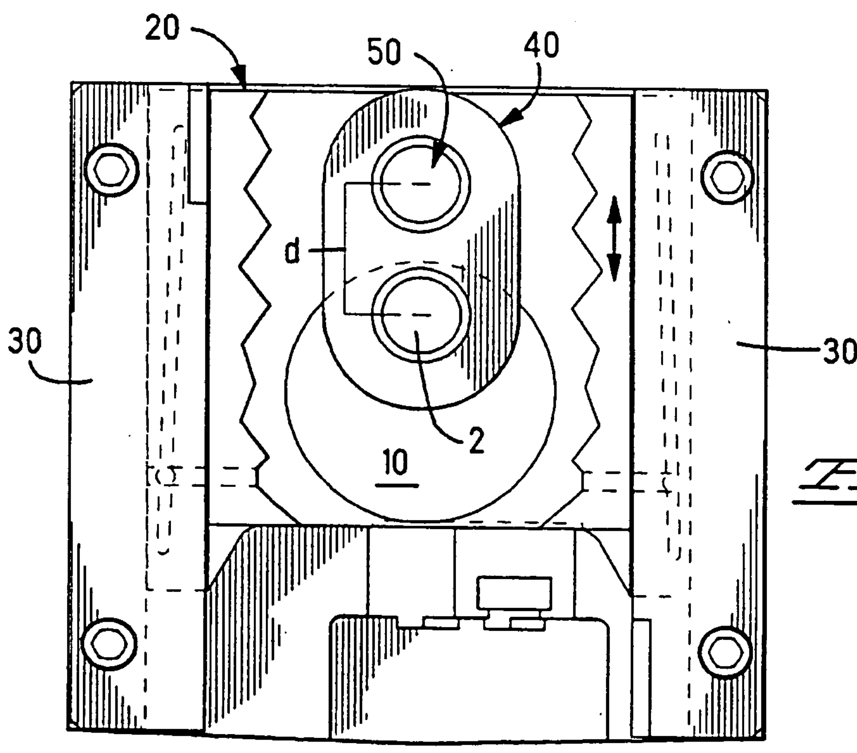


Fig. 5

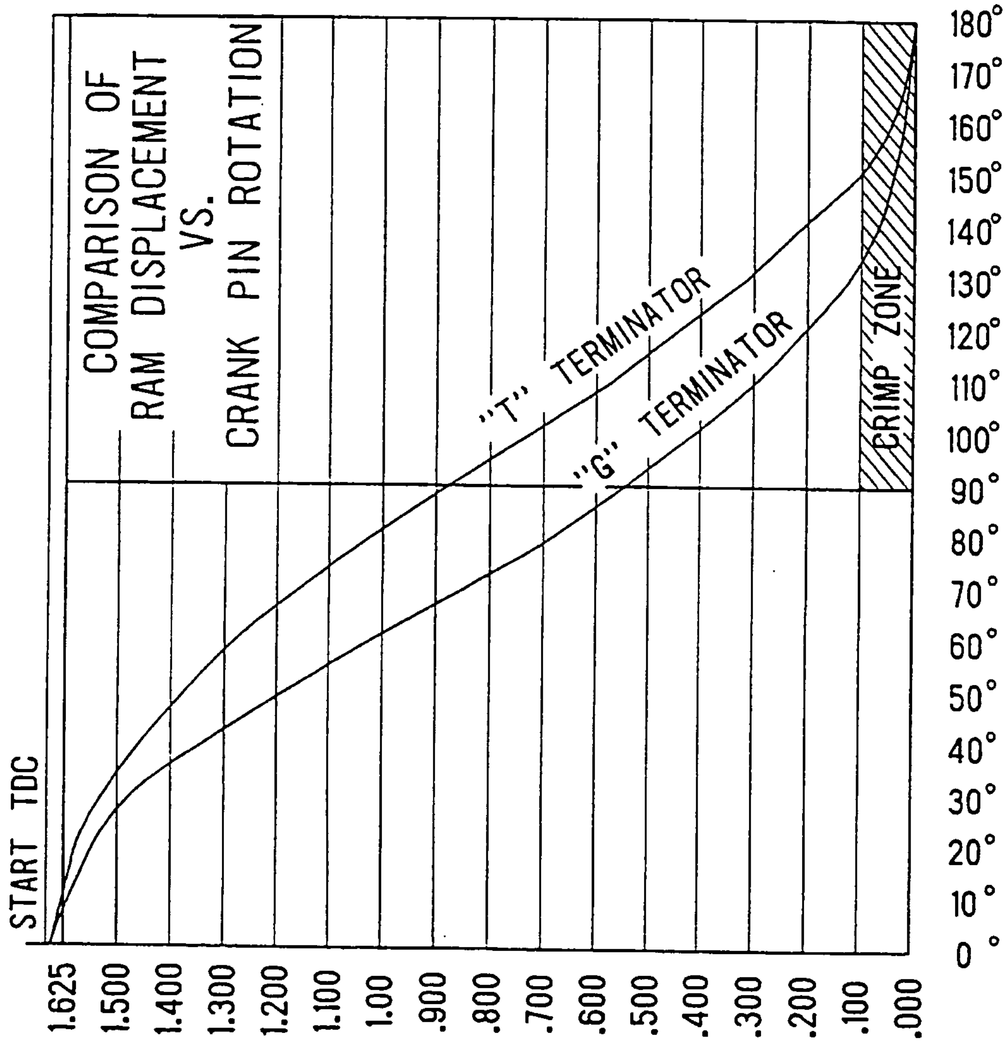
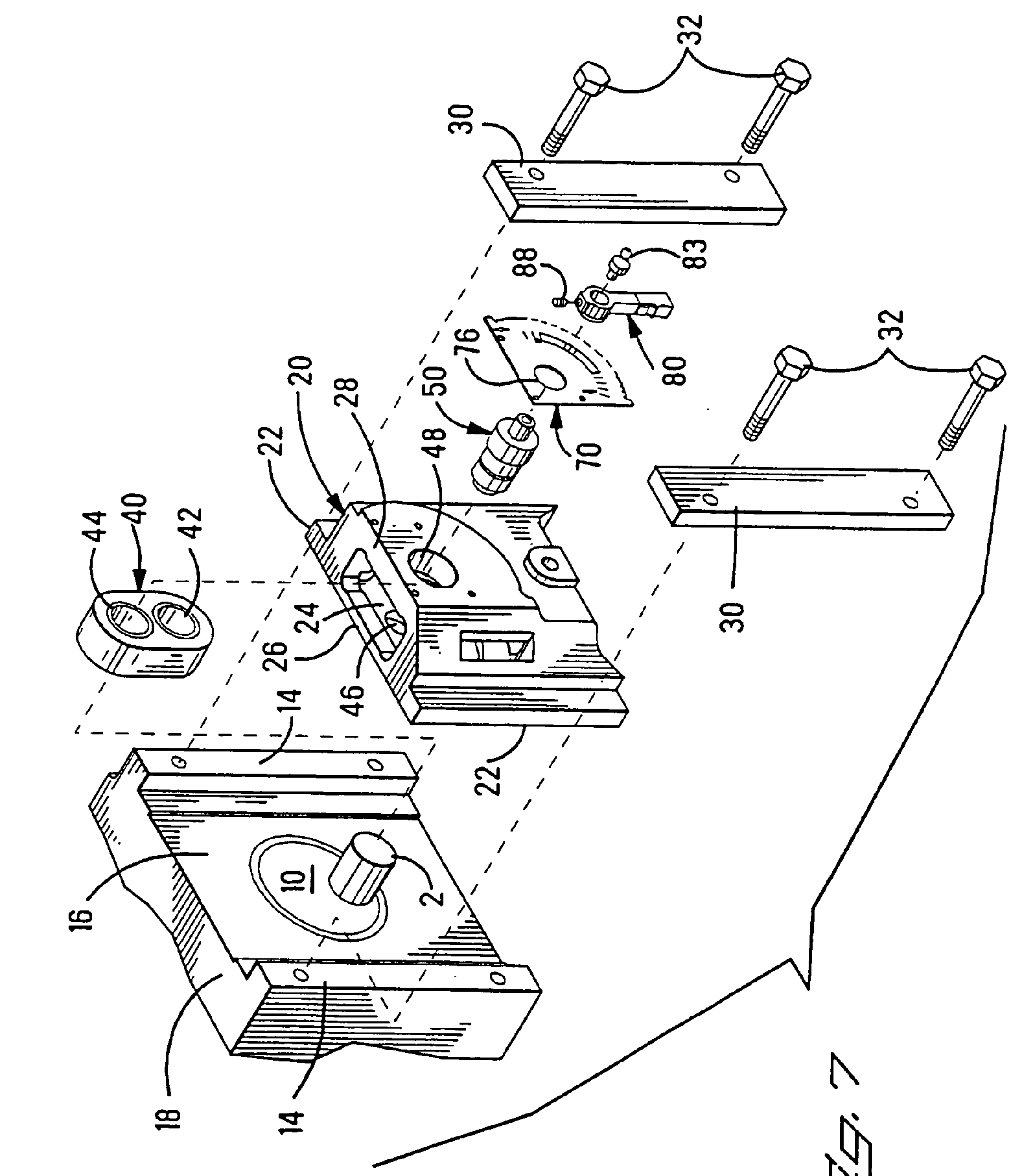

COMPARISON OF
RAM DISPLACEMENT
VS.
CRANK PIN ROTATION
START TDC
"T" TERMINATOR
"G" TERMINATOR
CRIMP ZONE
1.625
1.500
1.400
1.300
1.200
1.100
1.00
.900
.800
.700
.600
.500
.400
.300
.200
.100
.000
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°

Fig. 6


32
30
88
83
76
50
70
80
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28
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30
32

Fig. 7

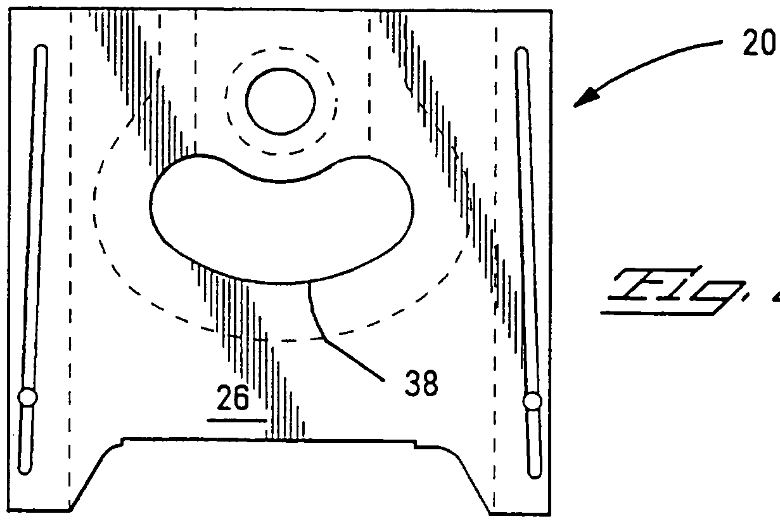

Fig. 8

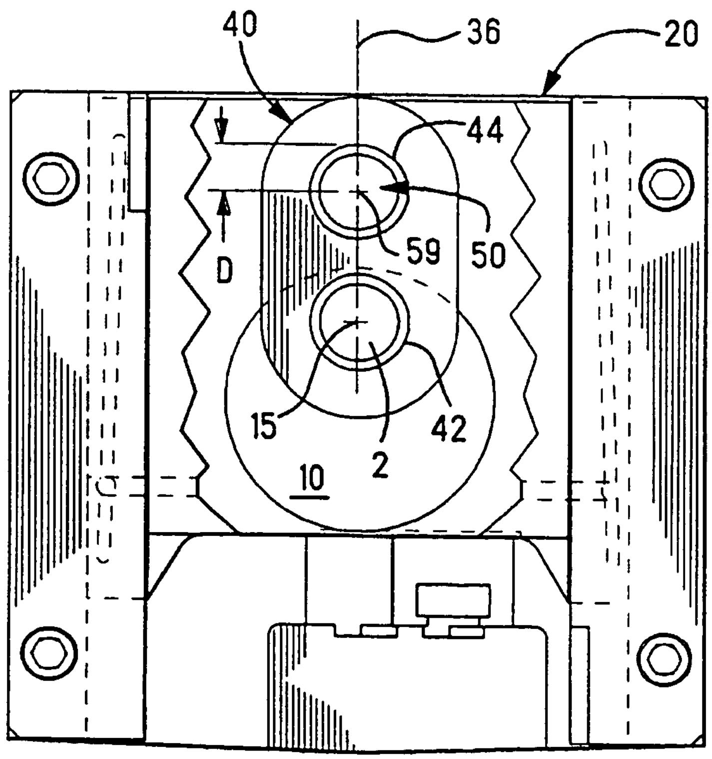

Fig. 10

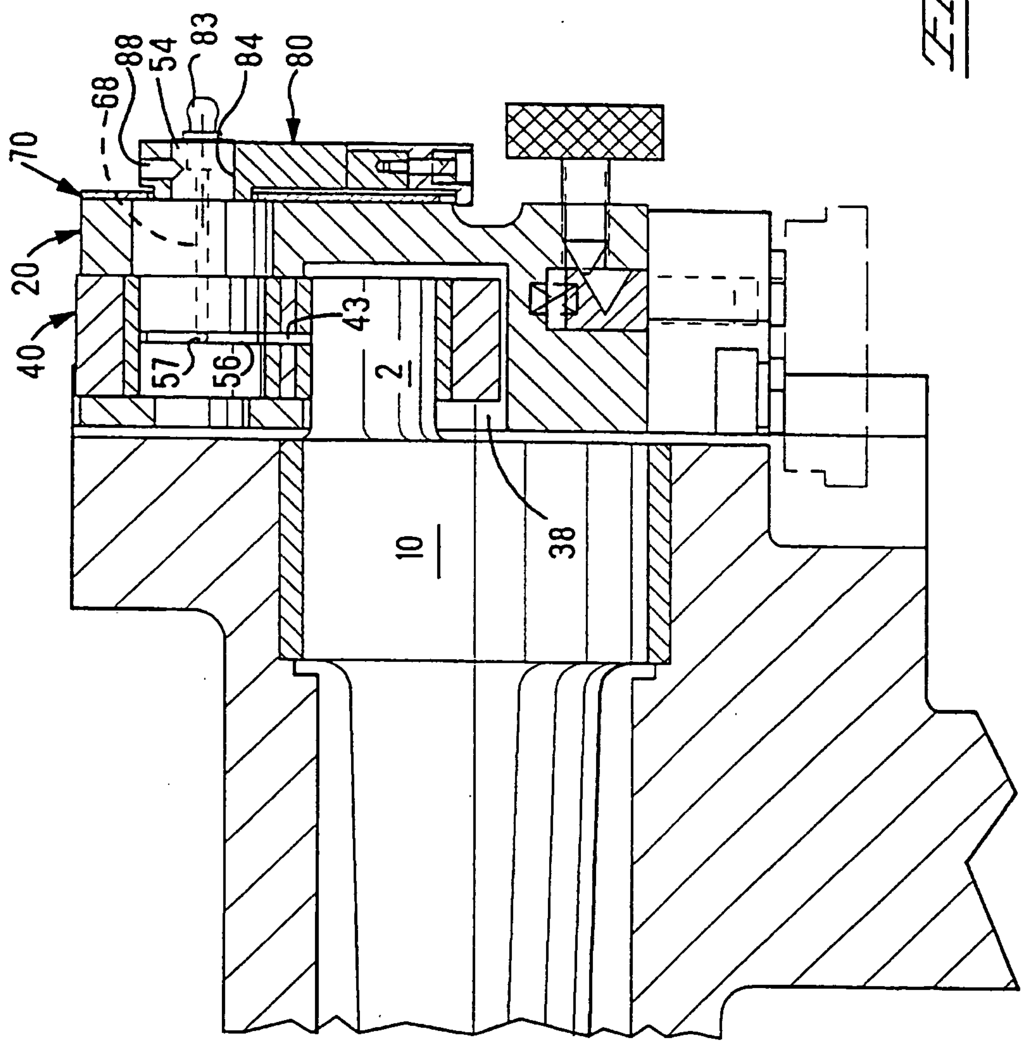

Fig. 9

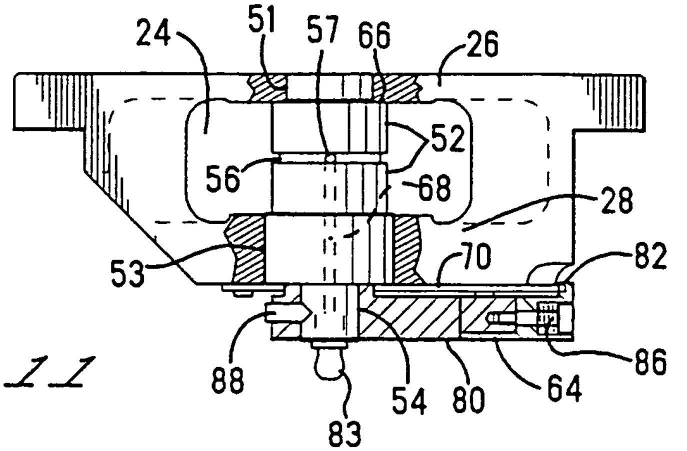

Fig. 11

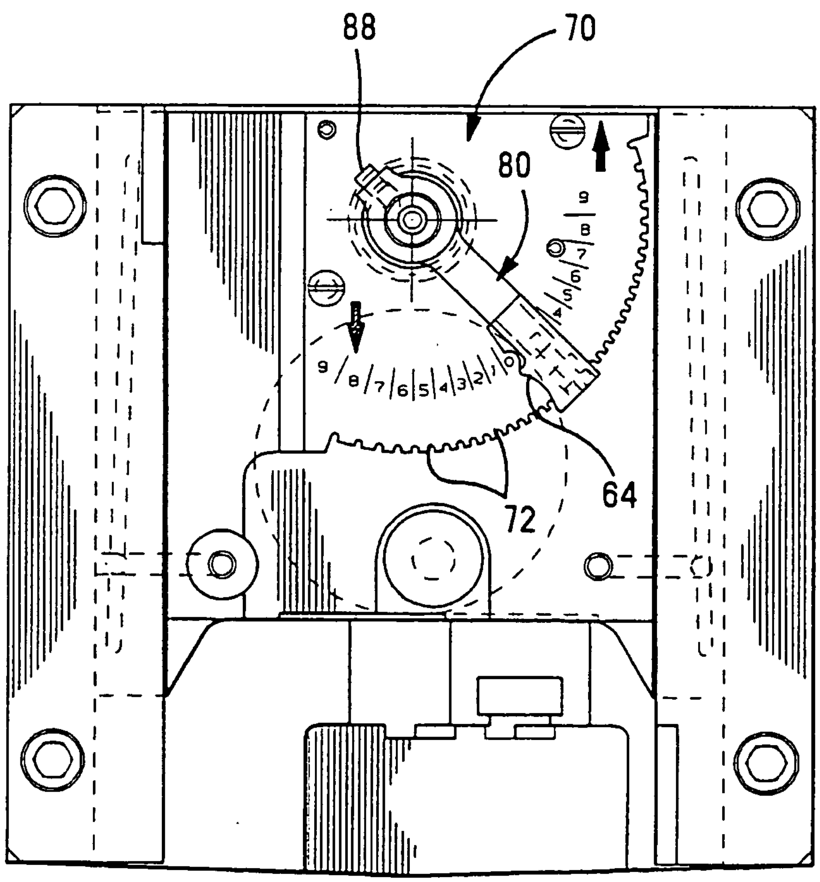

Fig. 12

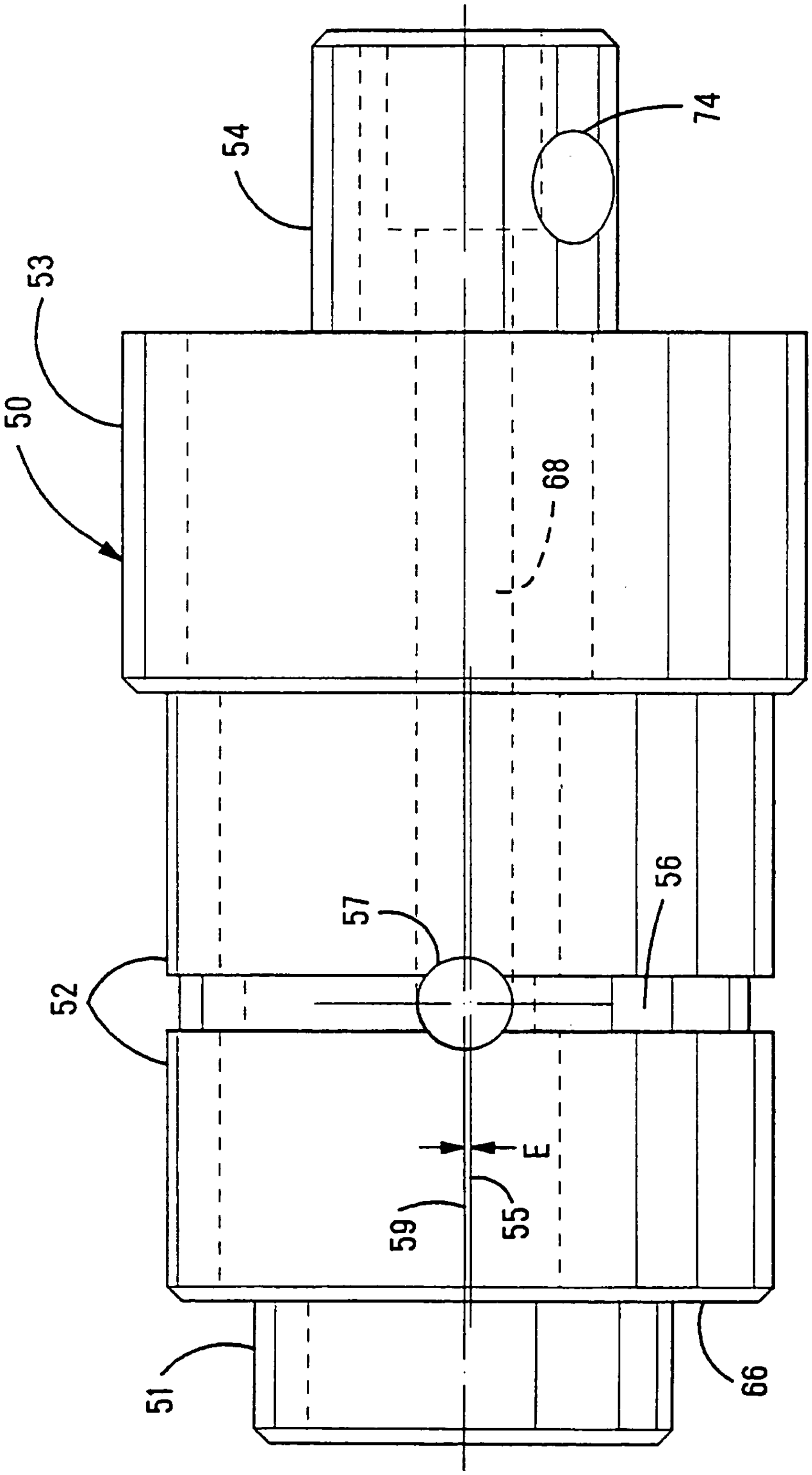

Fig. 13

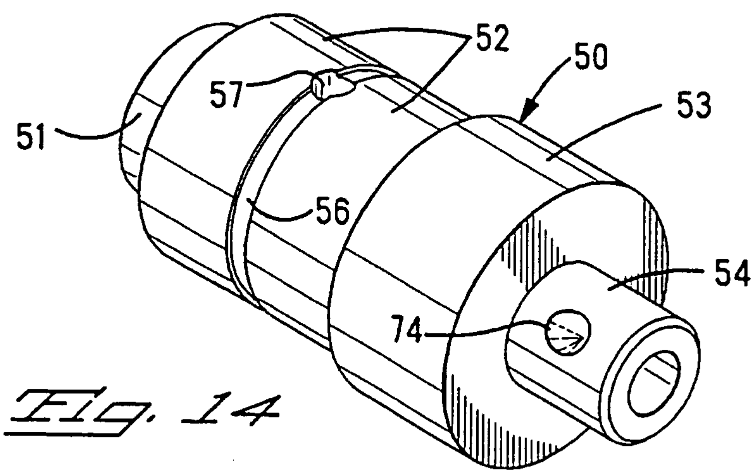

Fig. 14

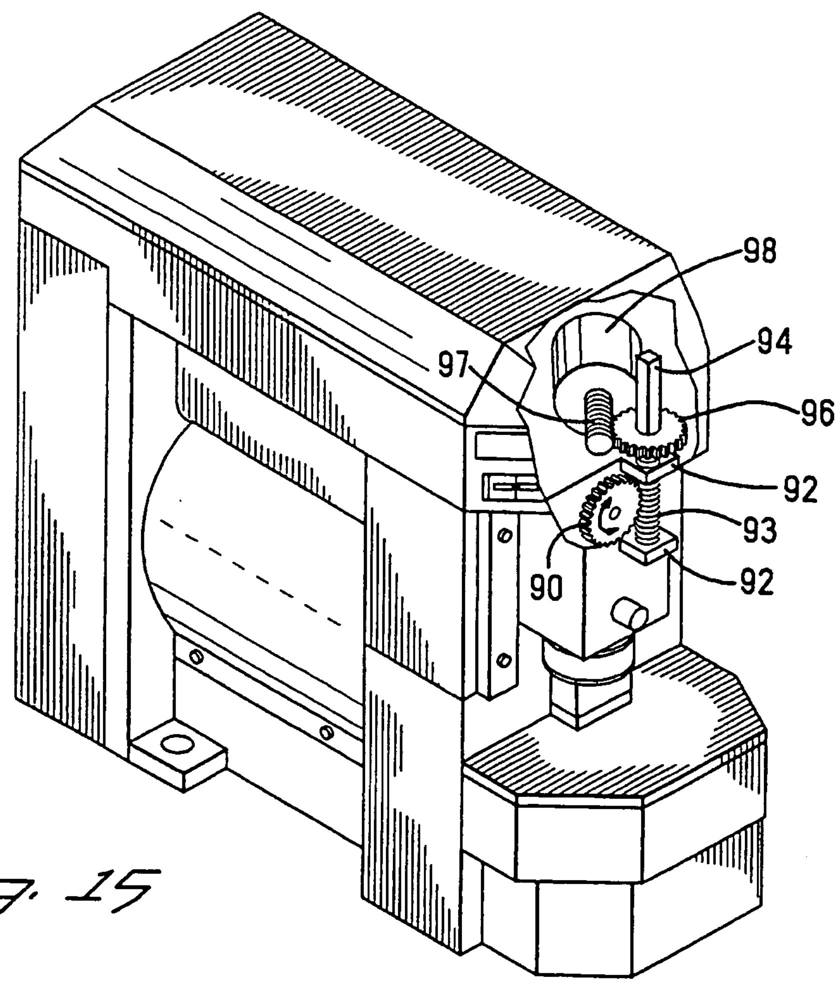

Fig. 15